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THE PRE-WISCONSIN DRIFT OF NORTH DAKOTA

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Considerably over one-half of North Dakota is covered by Wisconsin drift, which is found east of the Missouri plateau and also occupies a belt of country along the eastern margin of the plateau. The western border of the Wisconsin drift is marked by the wide, massive Altamont Moraine which crosses the state diagonally from northwest to southeast and has a width in places of 20 miles. West of this moraine there is an older drift sheet which extends from 70 to 130 miles beyond the Wisconsin drift and in North Dakota covers an area at the surface of approximately 19,000 square miles. The border of this older drift crosses the Montana boundary about 30 miles north of the Northern Pacific Railroad. This older drift undoubtedly underlies the Wisconsin drift of eastern North Dakota, but with possibly one exception it has not been observed in outcrops or recognized in wells.

East of the Missouri River the pre-Wisconsin drift, while covered in many places by outwash silt from the Altamont Moraine, is present in Emmons, Burleigh, eastern McLean and Mountrail, and perhaps in Williams and Divide counties. West of the Missouri River the older drift covers most of Morton, Dunn, and McKenzie counties, a corner of Stark, and all of Mercer and Oliver counties. In this area west of the river outcrops are not uncommon, and thus the region is the most favorable in the state for the study of the older drift sheet.

The following account of some of the features of the pre-Wisconsin drift is based on observations made during the course of field work for the North Dakota Geological Survey, a portion of the time in co-operation with the United States Geological Survey, in Morton, Dunn, McKenzie, Burleigh, and other counties during the years 1909 to 1914 inclusive.

The older drift west of the Missouri is in most places thin and has undergone great erosion. The deposit perhaps never had any considerable thickness in this region except locally, where it forms moraines, and much of the glacial material which was formerly present has been swept away by streams. The drift throughout much of the area is thus represented by bowlders and gravel, the coarser materials left behind when the finer débris, such as clay and sand, was carried off. There are extensive tracts where little or no glacial material is present and where only an occasional bowlder or a patch of gravel indicates that the ice sheet once covered this region. The western margin of the older drift is therefore poorly defined, and the mapping of it is based largely on the distribution of glacial bowlders and gravel.

As would be expected from the foregoing characters, the pre-Wisconsin drift has not, except in certain restricted areas, affected the topography to any large extent. The region is one of many streams and mature drainage, in striking contrast with the area of the Wisconsin drift, with its few streams, numerous lakes, and youthful topography.

PRE-WISCONSIN DRIFT OF BURLEIGH COUNTY

East of the Missouri River in Burleigh County, between the river and the Altamont Moraine, the older drift is present, but the occasional outcrops appear to indicate that it forms only a thin veneer over the underlying rocks, seldom exceeding 8 or 10 feet in thickness. It outcrops in the bluffs of the Missouri River 3 miles northwest of Bismarck, where 10 feet of till is found, and in the cut at the east end of the Northern Pacific bridge it attains a thickness of 15 to 20 feet. The bowlder clay appears in a number of the cuts along the Minneapolis, St. Paul & Sault Ste. Marie Railroad north of Bismarck, here generally associated with water-laid drift. It also outcrops at several points on Apple Creek, where it shows a thickness of 10–12 feet.

DRIFT IN MORTON COUNTY

West of the Missouri River in Morton County the glacial drift is represented almost wholly by gravel and bowlders, the latter occurring in great numbers. These bowlders, which are mostly granite, thickly cover the surface in many localities, resting directly on the bedrock, and except in rare instances no drift clay is associated with them. In some places they are scattered loosely over the ground, but in many others they form a bed or pavement in which the individual bowlders are in contact with each other. These bowlder deposits or bowlder beds are especially noticeable on the tops of divides and on upland areas. The bowlders vary in size from 6 or 8 inches to several feet in diameter, large ones measuring 8 and 10 feet being seen occasionally.

MORAINES OF LITTLE HEART RIVER BASIN

The most interesting and notable occurrence of glacial till in Morton County is found in the basin of the Little Heart River where the drift has been heaped up into morainic hills. During the Glacial Period this basin was probably occupied by an ice lobe of the continental glacier, and this lobe formed the belt of morainic hills which nearly encircles the broad valley plain and deposited more or less drift in the preglacial valleys of the Little Heart and its tributaries. As the ice

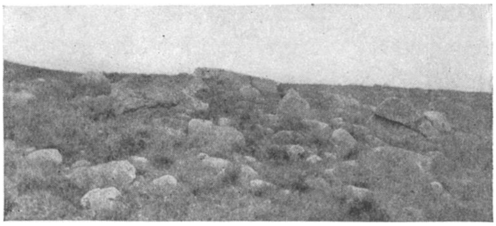

FIG. 1.—Bowlder-covered moraine hill of the pre-Wisconsin drift, Little Heart Basin, northeastern Morton County.

melted, the waters flowing from it deposited much outwash silt in the form of valley trains sloping away from the moraines. A number of the morainic hills have been partially buried by the outwash silt and rise like islands from the level plain of the valley train. The morainic belt of bowlder-covered hills and ridges is found near the base of the slopes on either side of the two valleys tributary to that of the Little Heart River (Fig. 1). Moraines cross the valley in three places and one belt of ridges and hills continues unbroken along the south side of the valley of the South Branch for a distance of 12 miles. The cultivated fields extend up to the moraine and end there where the soil becomes too rocky and the slopes too steep for cultivation.

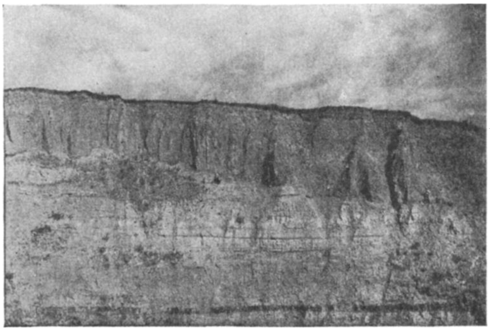

FIG. 2.—Pre-Wisconsin till overlying Fort Union beds on Tobacco Garden Creek several miles above its mouth, McKenzie County.

DRIFT IN MC KENZIE COUNTY

Near the western boundary of North Dakota the pre-Wisconsin ice sheet reached 35-40 miles south of the Missouri River and thus covered the greater part of McKenzie County which lies between the Yellowstone, Missouri, and Little Missouri rivers. The older drift left by this ice sheet is well shown in many places in this

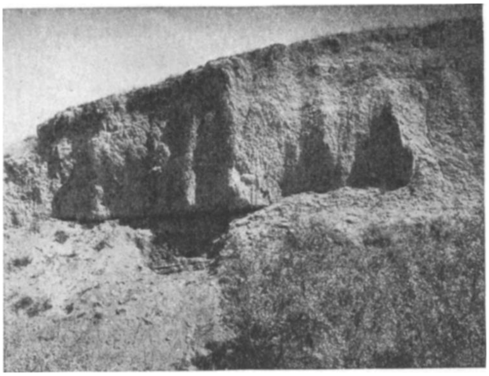

FIG. 3.—Pre-Wisconsin till resting on stratified sand and gravel on Tobacco Garden Creek, near its mouth.

region and the glacier also caused important drainage changes. The best exposures are found on Sand Creek, a short tributary of the Missouri River several miles east of Tobacco Garden Creek, on Tobacco Garden Creek, and on Clear Creek, a tributary of the latter.

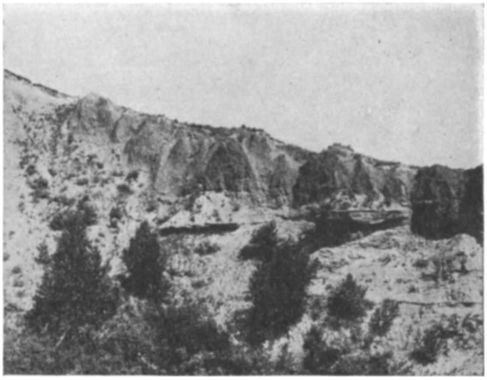

FIG. 4.—Pre-Wisconsin drift resting on Fort Union sandstone, valley of Clear Creek, a tributary of Tobacco Garden Creek, northeastern McKenzie County.

Near the mouth of Tobacco Garden Creek appears 58 feet of till in a cut bank. It is yellowish gray or drab in color, contains many small bowlders, and rests on Fort Union beds (Fig. 2). Not far from here is seen 18 feet of bowlder clay overlying 15 feet of well-stratified sand and gravel (Fig. 3).

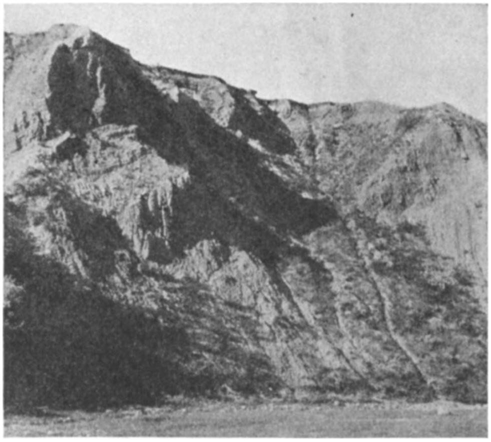

FIG. 5.—Pre-Wisconsin drift exposed on the tributary of Sand Creek, northeastern McKenzie County.

The valley of Clear Creek was partly filled with drift and there are many good outcrops of bowlder clay in the frequent cut banks along the stream where from 30 to 40 feet and over of till is exposed (Fig. 4). The greatest thickness found along this creek was in Sec. 36, T. 152 N., R. 97 W., where in a high bluff 100 feet of dark gray till overlies 100 feet of soft Fort Union sandstone. This outcrop lies within the morainic area to be described later, which probably accounts for the exceptional thickness of the pre-Wisconsin drift at this point.

Another excellent drift section occurs in this same morainic area 3 miles west and one-half mile south of Charlson, or 5 miles south of the Missouri River on a tributary of Sand Creek (Fig. 5). Here the following section appears in the steep bluff which rises abruptly from creek-level:

	Ft.	In.
Sandy clay and soil	2	
Sand and clay in alternating bands	8	
Gravel		8
Sand and clay in alternating layers	3	
Gravel, coarse		8
Sand	2	4
Gravel	7	8
Till or bowlder clay, dark gray in color, and containing large numbers of pebbles and bowlders imbedded in the tough, hard clay. A large proportion of the bowlders and pebbles are composed of compact limestone and the till contains considerable blue shale (Pierre ?). Thickness of till exposed above the creek	61	
	85	4

The sand and gravel forming the stratified drift of the foregoing section are light yellow in color. The drift hills just back of the bluff rise 50–60 feet above the top of section, so that the total thickness of the drift above creek-level is from 140 to 150 feet.

BOWLDER BED ON THE MISSOURI RIVER

An interesting bowlder deposit belonging to the pre-Wisconsin drift is found along the Missouri River just above water-level, 2 miles below the Nesson Ferry and one-half mile below the mouth of Tobacco Garden Creek (Fig. 6). This bed of bowlders shows a thickness, above the normal stage of the river, of 12–14 feet and its depth below water-level was not determined. The deposit is well exposed along the water's edge for a distance of nearly 100 yards, and scattered bowlders and ferruginous gravel occur at intervals for another 200 yards. Overlying the bowlders is 15 feet of gravel, which is overlain in turn by silt and fine sand extending to the top of the terrace, 100 feet above the river. The bowlder bed is composed of bowlders of all sizes, those from 2 to 3 feet in diameter being quite common, though those less than 1 foot in diameter are most abundant. One sandstone bowlder measured 14 feet in length, another was 9 feet long, and another 4 feet. Granite, limestone, petrified wood, and sandstone bowlders are found, together with other kinds of rock. The interstices between the coarser materials are filled with gravel and sand, and the whole deposit is cemented into a rather firm, indurated mass. It is very ferruginous and brown from the limonite forming the cementing material, and in many places the bowlders are firmly held by the iron cement and sand, which serve as a matrix in which the bowlders are imbedded; when the latter weather out their shape is preserved in the matrix.

While some of the bowlders of this deposit may have been brought here by floating ice, it is probable that most of the deposit was left here by the pre-Wisconsin ice sheet when it advanced south of the river. The finer materials of the drift, if they were ever present, have been carried away, leaving the gravel and bowlders, which were subsequently cemented by the iron of the surface waters.

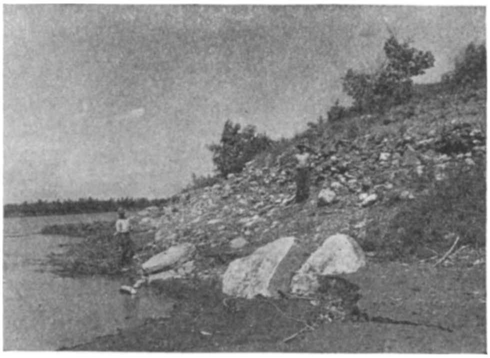

FIG. 6.—Bowlder bed on the Missouri River near mouth of Tobacco Garden Creek, McKenzie County.

MORAINE OF THE PRE-WISCONSIN DRIFT

Mention has been made on a previous page of the moraines of the Little Heart River Basin, and in McKenzie County a much more extensive moraine of the pre-Wisconsin drift forms a prominent topographic feature of the region. It lies in the northeastern part of the county, east of Tobacco Garden Creek, where it extends on the upland from the edge of the Missouri Valley bluffs north of Charlson in a southwesterly direction to the valley of Timber Prong Creek in Secs. 14 and 15, T. 151 N., R. 97 W. It has a length of 16 miles, an average width of 2 miles, and its area is about 30 square miles. This moraine shows well from Charlson, where its ridges and hills are seen rising from 100 to 150 feet above the flat plain in the foreground (Fig. 7). Within the morainic area the surface is rough and hilly and the ground is thickly strewn with bowlders. The topography is typically morainic, with numerous irregular hills and ridges, while scattered among the hills are great numbers of hollows or kettle-holes, some containing water and others dry. Many of the hills rise 50–125 feet above the bottom of the kettle-holes.

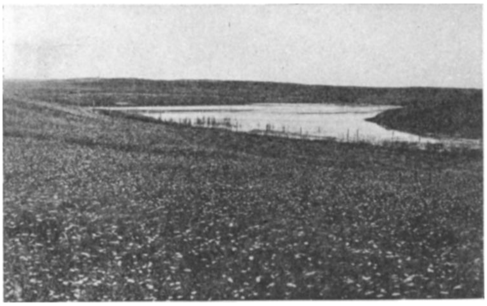

FIG. 7.—Small lake in the moraine of the pre-Wisconsin drift near Charlson, northeastern McKenzie County.

Where this moraine crosses the valley of Timber Prong Creek it forms a dam, which holds back the waters of the upper valley and forms a lake known locally as Dimick Lake. This moraine lake is very irregular in shape and has an area of between two and three square miles.

North of the Missouri River another morainic belt occurs which may be part of the pre-Wisconsin moraine just described as extending southwest from the vicinity of Charlson, though it is perhaps more likely to have been formed by the Earlier Wisconsin ice sheet referred to on another page. It lies from 2–3 miles west of White Earth Creek and with a width of 1–2 miles extends north and south a distance of at least 6 or 8 miles between the Missouri River and the Great Northern Railroad. Fifteen or 20 miles or more west of the Altamont Moraine the railroad crosses a well-developed moraine extending 4 or 5 miles and perhaps more north and south of Temple, and has a width of several miles. This hilly belt lies about 9 miles west of the above-mentioned moraine near White Earth Creek.

CHARACTERISTICS OF THE PRE-WISCONSIN DRIFT

The topography of the older drift and the large amount of erosion it has suffered compared with the Wisconsin till have been mentioned on a previous page, where it was shown that in many places only the coarser materials of the drift—the pebbles and bowlders—remain as evidence that the ice sheet once covered the region. But the color of the pre-Wisconsin till is generally unlike that of the Wisconsin drift. The latter is commonly light yellow to light gray in color as exposed in railroad cuts or along stream valleys, but where the deeper till appears in fresh excavations it is seen to have the blue color of the unoxidized clay. The pre-Wisconsin till, on the other hand, where best exposed on Sand and Clear creeks in northeastern McKenzie County (Fig. 8), is dark gray in color throughout the maximum observed thickness of over 100 feet.

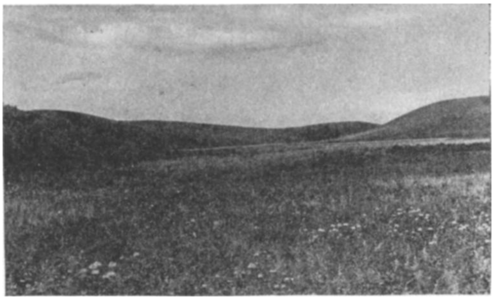

FIG. 8.—The valley of Clear Creek where it cuts through the moraine of the pre-Wisconsin drift, northeastern McKenzie County.

Except in the morainic areas the thickness of the pre-Wisconsin drift is not great. West of the Missouri River it is seldom as much as 8 or 10 feet and generally the thickness is not over 2 or 3 feet or less. The thinness of the older drift is due partly to erosion which has removed much of the glacial material and over a large part of the area left only bowlders or a thin veneer of gravel, but partly perhaps also to the fact that the drift may never have been very thick in this region.

BOUNDARY OF THE PRE-WISCONSIN DRIFT

Chamberlin and Salisbury many years ago noted the presence of an older drift beyond the Altamont Moraine and its approximate boundary was shown on their map.[1] The more detailed work of recent years has shifted the margin somewhat farther west and south and it is now provisionally located as shown on the accompanying map (Fig. 9).

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[1] "Terminal Moraine of the Second Glacial Epoch," *Third Ann. Report U.S. Geol. Surv.*, pp. 291–402; also Plate XXXV.

Glacial drift is found 50 miles south of the mouth of the Yellowstone River, or within less than 15 miles of Glendive, Montana. For a distance of 50 miles east of the western boundary of North Dakota the drift margin extends approximately east and west and lies 30–40 miles south of the Missouri River. North of the Killdeer Mountains the boundary swings sharply to the south, and crossing the Knife River near the western edge of Dunn County it takes a general southeasterly course across the state. The margin of the drift is believed to cross the Northern Pacific Railroad and the Heart River between 2 and 3 miles west of Gladstone. That a lobe of the ice sheet crossed the Heart River at Gladstone is shown by the presence of thick deposits of drift gravels on the upland 1–2 miles south of the Heart and at an elevation of between 100 and 200 feet above river-level. In places the gravel and sand have a thickness of at least 90 feet, and the deposit contains a number of good-sized granite bowlders. A well-defined gravel ridge marks the edge of the drift for 3 or 4 miles in this area south of the Heart River at Gladstone. This ridge rises 30–40 feet above the surface on either side and falls away rather abruptly on the south, while on the north the slope is more gradual.

There is no evidence that the ice sheet extended more than 2 or 3 miles south of the railroad between Gladstone and Richardton, but in this vicinity glacial gravel and a few small bowlders occur that far south. Between the Cannon Ball and Heart rivers glacial bowlders are found as far west as Elgin, or within 12 miles of the western border of Morton County. In general the drift margin between the Killdeer Mountains and the South Dakota line lies from 40–60 miles west of the Missouri River.

Thickness of the ice sheet.—In the vicinity of Berg in northeastern McKenzie County there are twelve or fifteen high buttes, known as the Blue Buttes, which are irregularly distributed over an area of 15 or more square miles. Many glacial bowlders occur on top of these buttes at an elevation of over 2,700 feet above sea-level, or 1,000 feet above the Missouri River only 6 miles to the east.

Since the buttes rise nearly 500 feet above the surrounding upland the ice sheet probably had at least this thickness in order to override them and deposit bowlders on their summits. Another

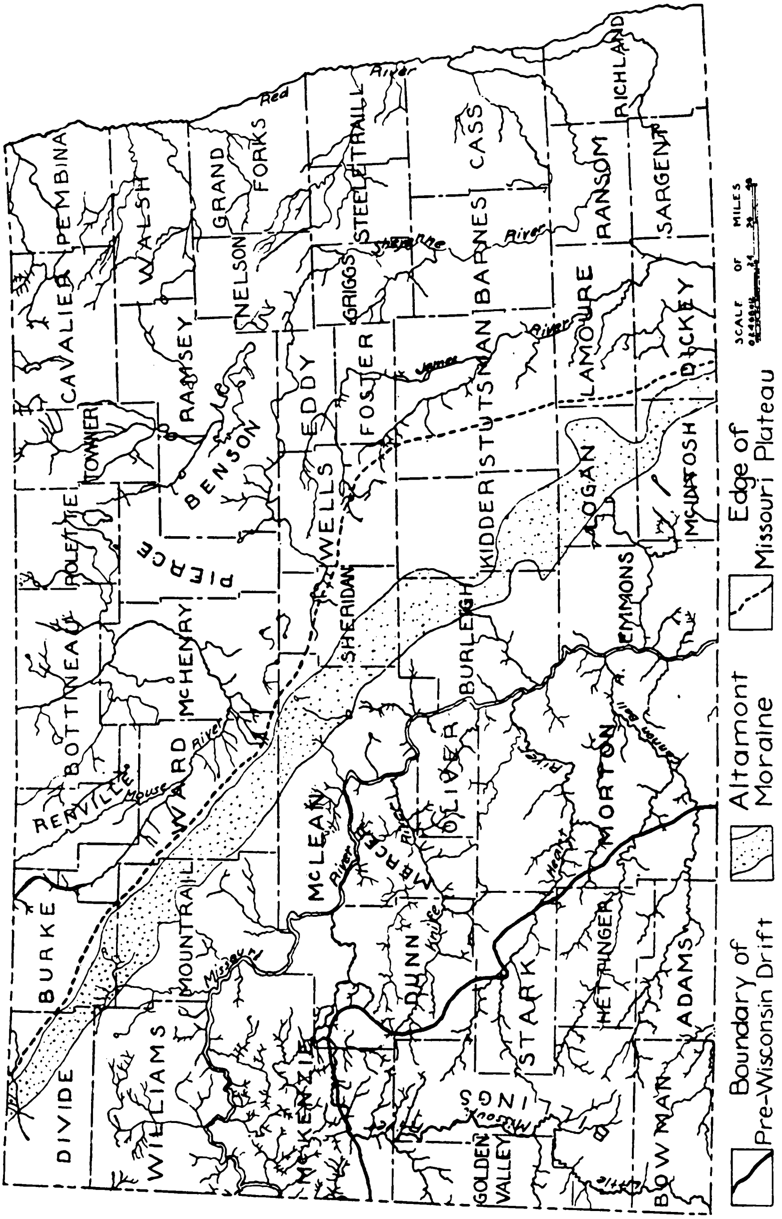

FIG. 9—Map showing margin of pre-Wisconsin drift and Altamont Moraine in North Dakota

explanation for the presence of the bowlders on top of the high buttes is that the ice upon encountering these obstructions was buckled up as it passed over them. But it seems more probable that the ice sheet which was able to push across the deep valley of the Missouri River and advance 40–60 miles beyond was thick enough to submerge the Blue Buttes and pass on over them. The terminus of the continental glacier was not far from 15 miles south of the Blue Buttes, since the ice advanced only as far as the Killdeer Mountains. Back about 15 miles from the edge the ice sheet therefore doubtless had a thickness over the upland plain of considerably over 500 feet. The ice which filled the Missouri River Valley must have had locally a thickness of 1,000 feet or over.

Age of the older drift.—That the drift west of the Missouri River is much older than the Wisconsin drift is evident from the great amount of erosion it has undergone. Over much of the region the finer materials of the till have been swept away, leaving only bowlders and gravel. The older drift also differs in color, being considerably darker than the Wisconsin. This pre-Wisconsin drift has commonly been regarded as Kansan and there is perhaps more reason for referring it to the invasion of the Kansan ice sheet than any of the other early ice invasions.

The drift north of the Missouri River and west of the Altamont Moraine appears to be younger than the drift south and west of the river. It has undergone less erosion and resembles the typical Wisconsin till in color. Calhoun believes that the drift of northeastern Montana is of Wisconsin age, and on his map this drift is shown as extending to within about 40 miles of the North Dakota line.[1] The extra-morainal drift north of the Missouri River in Williams County is undoubtedly continuous with the drift sheet west of here in Montana, in which case it is probably of Wisconsin age, and belongs to the Early Wisconsin stage.

If this view is correct, there are three drift sheets in North Dakota—the Late Wisconsin east of the Altamont moraine, the Early Wisconsin west of the moraine and north of the Missouri River, and the Kansan drift west and south of the river.

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[1] Fred. H. H. Calhoun, "The Montana Lobe of the Keewatin Ice Sheet," *Prof. Paper No. 50, U.S. Geol. Survey*, 1906, pp. 52–57.